SEMINAR NOTICE

Department of Electrical and Systems Engineering

OPTICAL MICRORESONATORS WITH APPLICATIONS ON LASING AND SINGLE NANOPARTICLE DETECTION

PhD Preliminary Research Examination

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Abstract: Whispering gallery modes (WGMs) microresonators have attracted great interests due to significantly enhanced light-matter interaction originating from their ultra-high quality factors and highly confined light field in micro-scale mode volumes. They are suitable for a variety of applications including bio/chemical sensing, lasing, nonlinear optics, and so forth. However, temperature fluctuations as one of the most common environmental noises disturb the cavity resonance and thus degrade the device stability and sensitivity. We functionalize the surface of a silica resonator with a thin layer of polymer with opposite thermo-optic coefficient to silica to eliminate the thermal effect caused by temperature variation. We have demonstrated that functionalized resonator is resistant to temperature fluctuations and therefore forms an excellent candidate for highly-sensitive sensing applications. In addition, the polymer layer itself can be used as a sensitive transducer for mechanical force, moisture, chemical, etc. Moreover, polymer coating provides a convenient mean to integrate materials such as optical gain medium, magnetic material, and conductive medium to the resonator. The wide varieties of polymers greatly diversify the applicability of the resonator system.

For lasing application, we demonstrate ultra-low threshold and ultra-narrow linewidth on-chip microlasers by doping the resonators with rear-earth ions through solgel method. Both self-pulsation and continuous-wave laser operations are obtained. We propose that the microlaser can be used for real-time and label-free single nanoparticle detection by monitoring the self-heterodyning beat note of the split lasing modes induced by binding particles. It surpasses the detection limit of existing micro- and nano- photonic resonant devices. We demonstrate detection of polystyrene and gold nanoparticles as small as 15 nm and 10 nm in radius, respectively, and Influenza A virions. The built-in self-heterodyne interferometric method achieved in a monolithic microlaser provides a self-reference scheme with extraordinary sensitivity, and paves the way for detection and spectroscopy of nano-scale objects using micro- and nano-lasers.

DATE: Wednesday, March 23, 2011
TIME: 10:00 a.m.
PLACE: Bryan Hall, Room 305

Thesis advisor:
Dr. Lan Yang

This seminar is in partial fulfillment
of the Doctor of Philosophy degree

Washington University in St. Louis
SCHOOL OF ENGINEERING & APPLIED SCIENCE